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TITLE: STEEL TUBE FOR AIR BAG, WITH HIGH STRENGTH AND HIGH TOUGHNESS, AND ITS PRODUCTION

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## ABSTRACT:

PROBLEM TO BE SOLVED: To provide a steel tube having a high dimensional accuracy, excellent in workability, and suitable for parts for an air bag, requiring high strength and high toughness, and its production.

SOLUTION: The steel tube for an air bag, with a high strength and high toughness, has a composition consisting of 0.05-0.15% C,  $\leq 0.50\%$  Si, 0.30-2.00% Mn,  $\leq 0.020\%$  P,  $\leq 0.020\%$  S,  $\leq 0.10\%$  Al, and the balance Fe with inevitable impurities. This steel tube has high dimensional accuracy and excellent workability and weldability and can secure high strength and high toughness. Further, after tubemaking of this steel, the resultant steel tube is cold-worked into prescribed size and used in this as-cold-worked state, or the steel tube is subjected, after cold working, to annealing, normalizing, or quench-and-temper treatment, by which the steel tube having high dimensional accuracy, excellent in workability and weldability, and suitable for parts for an air bag, requiring high strength and high toughness, can be produced.

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(54) 【発明の名称】 高強度高靱性エアバッグ用鋼管とその製造方法

(57) 【要約】

【課題】 高寸法精度で加工性に優れ、かつ高強度、高靱性が要求されるエアバッグ用部品に適した鋼管とその製造方法を提供する。

【解決手段】 C: 0.01%~0.20%、Si: 0.50%以下、Mn: 0.30%~2.00%、P: 0.020%以下、S: 0.020%以下、Al: 0.10%以下を含有し、残部がFeおよび不可避的不純物からなる高強度高靱性エアバッグ用鋼管で、高寸法精度で加工性と溶接性に優れ、かつ高強度、高靱性を確保できる。また、前記鋼を製管後、所定の寸法に冷間加工を施したまま、もしくは冷間加工後焼なまし、焼ならしまたは焼入れ焼戻し処理することによって、高寸法精度で加工性と溶接性に優れ、かつ高強度、高靱性が要求されるエアバッグ用部品に適する。

## 【特許請求の範囲】

【請求項1】 C:0.05%以上0.15%未満、Si:0.50%以下、Mn:0.30%~2.00%、P:0.020%以下、S:0.020%以下、Al:0.10%以下を含有し、残部がFeおよび不可避的不純物からなる高強度高靱性エアバッグ用鋼管。

【請求項2】 C:0.05%以上0.15%未満、Si:0.50%以下、Mn:0.30%~2.00%、P:0.020%以下、S:0.020%以下、Al:0.10%以下を含み、Mo:0.50%以下、V:0.10%以下、Ni:0.50%以下、Cr:1.00%以下、Cu:0.50%以下、Ti:0.10%以下、Nb:0.10%以下、B:0.005%以下のうち1種以上を含有し、残部がFeおよび不可避的不純物からなる高強度高靱性エアバッグ用鋼管。

【請求項3】 C:0.01%~0.20%、Si:0.50%以下、Mn:0.30%~2.00%、P:0.020%以下、S:0.020%以下、Al:0.10%以下を含有し、残部がFeおよび不可避的不純物からなる高強度高靱性エアバッグ用鋼管。

【請求項4】 C:0.01%~0.20%、Si:0.50%以下、Mn:0.30%~2.00%、P:0.020%以下、S:0.020%以下、Al:0.10%以下を含み、Mo:0.50%以下、V:0.10%以下、Ni:0.50%以下、Cr:1.00%以下、Cu:0.50%以下、Ti:0.10%以下、Nb:0.10%以下、B:0.005%以下のうち1種以上を含有し、残部がFeおよび不可避的不純物からなる高強度高靱性エアバッグ用鋼管。

【請求項5】 C:0.05%以上0.15%未満、Si:0.50%以下、Mn:0.30%~2.00%、P:0.020%以下、S:0.020%以下、Al:0.10%以下を含有し、残部がFeおよび不可避的不純物からなる鋼を製管後、所定の寸法に冷間加工を施したまま、もしくは冷間加工後焼なまし、焼ならしまたは焼入れ焼戻し処理することを特徴とする高強度高靱性エアバッグ用鋼管の製造方法。

【請求項6】 C:0.05%以上0.15%未満、Si:0.50%以下、Mn:0.30%~2.00%、P:0.020%以下、S:0.020%以下、Al:0.10%以下を含み、Mo:0.50%以下、V:0.10%以下、Ni:0.50%以下、Cr:1.00%以下、Cu:0.50%以下、Ti:0.10%以下、Nb:0.10%以下、B:0.005%以下のうち1種以上を含有し、残部がFeおよび不可避的不純物からなる鋼を製管後、所定の寸法に冷間加工を施したまま、もしくは冷間加工後焼なまし、焼ならしまたは焼入れ焼戻し処理することを特徴とする高強度高靱性エアバッグ用鋼管の製造方法。

【請求項7】 C:0.01%~0.20%、Si:

0.50%以下、Mn:0.30%~2.00%、P:0.020%以下、S:0.020%以下、Al:0.10%以下を含有し、残部がFeおよび不可避的不純物からなる鋼を製管後、所定の寸法に冷間加工を施したまま、もしくは冷間加工後焼なまし、焼ならしまたは焼入れ焼戻し処理することを特徴とする高強度高靱性エアバッグ用鋼管の製造方法。

【請求項8】 C:0.01%~0.20%、Si:0.50%以下、Mn:0.30%~2.00%、P:0.020%以下、S:0.020%以下、Al:0.10%以下を含み、Mo:0.50%以下、V:0.10%以下、Ni:0.50%以下、Cr:1.00%以下、Cu:0.50%以下、Ti:0.10%以下、Nb:0.10%以下、B:0.005%以下のうち1種以上を含有し、残部がFeおよび不可避的不純物からなる鋼を製管後、所定の寸法に冷間加工を施したまま、もしくは冷間加工後焼なまし、焼ならしまたは焼入れ焼戻し処理することを特徴とする高強度高靱性エアバッグ用鋼管の製造方法。

## 20 【発明の詳細な説明】

## 【0001】

【発明の属する技術分野】本発明は、高寸法精度で加工性と溶接性に優れ、かつ590N/mm<sup>2</sup>以上の高強度、高靱性が要求されるエアバッグ用に適した高強度高靱性エアバッグ用鋼管とその製造方法に関する。

## 【0002】

【従来の技術】近年、自動車産業においては、安全性を追求した装置の導入が積極的に進められているが、その中でも衝突時に乗員がハンドルやインストルメントパネルなどに衝突する前に、それらと乗員との間にガス等でエアバッグを展開させ、乗員の運動エネルギーを吸収して傷害軽減を図るエアバッグシステムが開発搭載されるに至っている。エアバッグシステムとしては、従来爆発性薬品を使用する方式が採用されてきたが、高価であり、かつ環境問題、リサイクル問題から近年アルゴンガス充填鋼管製アキュムレータを使用するシステムが開発された。アルゴンガス等のアキュムレータに用いる鋼管は、衝突時にエアバッグ内に吹出す不活性ガス等を常時300kgf/cm<sup>2</sup>に保ったうえで、衝突時少量の火薬点火時のガスを付加し、一気にガスを噴出させるので、極めて短時間に大きな歪速度で応力が付加されるため、従来の圧力シリンダーやラインパイプのような単なる構造物と異なり、高強度、高靱性と共に高寸法精度と加工性ならびに溶接性が要求される。

【0003】この用途に用いる鋼管製のアキュムレータの場合には、従来の冷間引抜き加工と応力除去焼鈍の組合せでは高強度化により靱性が低下し、上記要求を満足することはできない。また、鋼管を焼入れ焼戻しするのみでは、高強度、高靱性ならびに高加工性が得られたとしても、所定の高寸法精度が得られない等の問題点を有

していた。

【0004】また、他の方法としては、C:0.15~0.30%、Si:0.05~0.50%、Mn:0.30~1.00%、P:0.040%以下、S:0.010%以下を含み、残部がFeおよび不可避免の不純物からなる電鍍管を素材とし、焼入れ焼戻しによりベイナイト組織としたのち、冷間抽伸、応力除去焼鈍する方法（特開平4-191323号公報）、C:0.15~0.40%、Si:0.1~0.7%、Mn:0.5~2.5%、Cr:0.2~2.5%、Sol. Al: 0.01~0.05%を含有し、残部がFeおよび不可避免の不純物からなる鋼、またはC:0.15~0.40%、Si:0.1~0.7%、Mn:0.5~2.5%、Cr:0.2~2.5%、Sol. Al:0.01~0.05%と、Mo:0.05~1.0%、V:0.02~0.1%、Ni:0.2~2.5%、Ti:0.02~0.10%、Nb:0.02~0.10%、B:0.0005~0.005%のうちの1種以上を含有し、残部がFeおよび不可避免の不純物からなる鋼を素材として、熱間圧延により熱延鋼板とし、軟化焼鈍後、管状に成形、溶接して製造された鋼管を、所定の部品形状となるように冷間加工した後、850~1050℃で0.5~30分間加熱後空冷する方法（特開平5-302119号公報）等が提案されている。

【0005】

【発明が解決しようとする課題】上記特開平4-191323号公報に開示の方法は、ベイナイト組織化による切削性の向上を図ったものであるが、焼入れによりベイナイト組織を得るためにはどうしてもC量を増加させる必要があり、C:0.15~0.30%と高い値とする必要がある。しかしながら、このようにC量を高くし、かつベイナイト組織とした場合は、一般的に延性、韌性が乏しく、エアーバッグのアクキュムレータ用の管端絞り加工されるような用途には不向きであり、しかも溶接性等にも問題がある。

【0006】また、特開平5-302119号公報に開示の方法は、上記特開平4-191323号公報に開示の方法と同様、C:0.15~0.40%と高いため、一般的に延性、韌性が乏しく、エアーバッグ用のアクキュムレータのような管端絞り加工される用途には不向きであり、しかも溶接性等にも問題がある。

【0007】本発明の目的は、上記従来技術の欠点を解消し、高寸法精度で加工性と溶接性に優れ、かつ高強度、高韌性が要求されるエアーバッグ用部品に適した加工性に優れた高強度高韌性鋼管とその製造方法を提供することにある。

【0008】

【課題を解決するための手段】本発明者らは、上記目的を達成すべく鋭意試験研究を重ねた。その結果、エアーバッグシステムのアクキュムレータ用に適した所定の化学

成分を見出した。また、前記所定の化学成分の鋼を製管後、所定の寸法精度を得るために冷間加工を行い、その後所定の特性を得るため、熱処理しない場合、または焼なまし、焼ならしあるいは焼入れ焼戻し処理を施すことによって、高寸法精度で加工性と溶接性に優れ、かつ高強度、高韌性鋼管が得られることを究明し、本発明に到達した。

【0009】本発明の請求項1の高強度高韌性エアーバッグ用鋼管は、C:0.05%以上0.15%未満、Si:0.50%以下、Mn:0.30%~2.00%、P:0.020%以下、S:0.020%以下、Al:0.10%以下を含有し、残部がFeおよび不可避免の不純物からなる。このように、鋼中の化学成分を上記成分組成に限定することによって、エアーバッグのアクキュムレータ用として十分な強度、韌性と高寸法精度で高加工性と溶接性を確保することができる。

【0010】また、本発明の請求項2の高強度高韌性エアーバッグ用鋼管は、C:0.05%以上0.15%未満、Si:0.50%以下、Mn:0.30%~2.00%、P:0.020%以下、S:0.020%以下、Al:0.10%以下を含み、Mo:0.50%以下、V:0.10%以下、Ni:0.50%以下、Cr:1.00%以下、Cu:0.50%以下、Ti:0.10%以下、Nb:0.10%以下、B:0.005%以下のうち1種以上を含有し、残部がFeおよび不可避免の不純物からなる。このように、鋼中の化学成分を上記成分組成に限定することによって、エアーバッグのアクキュムレータ用として十分な強度、韌性と高寸法精度で高加工性と溶接性を確保することができる。

【0011】さらに、本発明の請求項3の高強度高韌性エアーバッグ用鋼管は、C:0.01%~0.20%、Si:0.50%以下、Mn:0.30%~2.00%、P:0.020%以下、S:0.020%以下、Al:0.10%以下を含有し、残部がFeおよび不可避免の不純物からなる。このように、鋼中の化学成分を上記成分組成に限定することによって、エアーバッグのアクキュムレータ用として十分な強度、韌性と高寸法精度で高加工性と溶接性を確保することができる。

【0012】さらにまた、本発明の請求項4の高強度高韌性エアーバッグ用鋼管は、C:0.01%~0.20%、Si:0.50%以下、Mn:0.30%~2.00%、P:0.020%以下、S:0.020%以下、Al:0.10%以下を含み、Mo:0.50%以下、V:0.10%以下、Ni:0.50%以下、Cr:1.00%以下、Cu:0.50%以下、Ti:0.10%以下、Nb:0.10%以下、B:0.005%以下のうち1種以上を含有し、残部がFeおよび不可避免の不純物からなる。このように、鋼中の化学成分を上記成分組成に限定することによって、エアーバッグのアクキュムレータ用として十分な強度、韌性と高寸法精度で高加

工性と溶接性を確保することができる。

【0013】また、本発明の請求項5の高強度高靱性エアーバッグ用鋼管の製造方法は、C:0.05%以上0.15%未満、Si:0.50%以下、Mn:0.30%~2.00%、P:0.020%以下、S:0.020%以下、Al:0.10%以下を含有し、残部がFeおよび不可避的不純物からなる鋼を製管後、所定の寸法に冷間加工を施したまま、もしくは冷間加工後焼なまし、焼ならしまたは焼入れ焼戻し処理することとしている。このように、鋼中の化学成分を上記成分組成に限定することによって、エアーバッグのアクキュムレータ用として十分な強度、靱性と高寸法精度で高加工性と溶接性を確保することができる。また、上記鋼を製管後、所定の寸法に冷間加工を施したまま、もしくは冷間加工後焼なまし、焼ならしまたは焼入れ焼戻し処理することによって、最終目的の特性に適した高強度、高靱性、高寸法精度で加工性と溶接性に優れた鋼管を得ることができる。

【0014】さらに、本発明の請求項6の高強度高靱性エアーバッグ用鋼管の製造方法は、C:0.05%以上0.15%未満、Si:0.50%以下、Mn:0.30%~2.00%、P:0.020%以下、S:0.020%以下、Al:0.10%以下を含み、Mo:0.50%以下、V:0.10%以下、Ni:0.50%以下、Cr:1.00%以下、Cu:0.50%以下、Ti:0.10%以下、Nb:0.10%以下、B:0.005%以下のうち1種以上を含有し、残部がFeおよび不可避的不純物からなる鋼を製管後、所定の寸法に冷間加工を施したまま、もしくは冷間加工後焼なまし、焼ならしまたは焼入れ焼戻し処理することとしている。このように、鋼中の化学成分を上記成分組成に限定することによって、エアーバッグのアクキュムレータ用として十分な強度、靱性と高寸法精度で高加工性を確保することができる。また、上記鋼を製管後、所定の寸法に冷間加工を施したまま、もしくは冷間加工後焼なまし、焼ならしまたは焼入れ焼戻し処理することによって、最終目的の特性に適した高強度、高靱性、高寸法精度で加工性と溶接性に優れた鋼管を得ることができる。

【0015】さらにまた、本発明の請求項7の高強度高靱性エアーバッグ用鋼管の製造方法は、C:0.01%~0.20%、Si:0.50%以下、Mn:0.30%~2.00%、P:0.020%以下、S:0.020%以下、Al:0.10%以下を含有し、残部がFeおよび不可避的不純物からなる鋼を製管後、所定の寸法に冷間加工を施したまま、もしくは冷間加工後焼なまし、焼ならしまたは焼入れ焼戻し処理することとしている。このように、鋼中の化学成分を上記成分組成に限定することによって、エアーバッグのアクキュムレータ用として十分な強度、靱性と高寸法精度で高加工性と溶接性を確保することができる。また、上記鋼を製管後、所定

の寸法に冷間加工を施したまま、もしくは冷間加工後焼なまし、焼ならしまたは焼入れ焼戻し処理することによって、最終目的の特性に適した高強度、高靱性、高寸法精度で加工性と溶接性に優れた鋼管を得ることができる。

【0016】また、本発明の請求項8の高強度高靱性エアーバッグ用鋼管の製造方法は、C:0.01%~0.20%、Si:0.50%以下、Mn:0.30%~2.00%、P:0.020%以下、S:0.020%以下、Al:0.10%以下を含み、Mo:0.50%以下、V:0.10%以下、Ni:0.50%以下、Cr:1.00%以下、Cu:0.50%以下、Ti:0.10%以下、Nb:0.10%以下、B:0.005%以下のうち1種以上を含有し、残部がFeおよび不可避的不純物からなる鋼を製管後、所定の寸法に冷間加工を施したまま、もしくは冷間加工後焼なまし、焼ならしまたは焼入れ焼戻し処理することとしている。このように、鋼中の化学成分を上記成分組成に限定することによって、エアーバッグのアクキュムレータ用として十分な強度、靱性と高寸法精度で高加工性と溶接性を確保することができる。また、上記鋼を製管後、所定の寸法に冷間加工を施したまま、もしくは冷間加工後焼なまし、焼ならしまたは焼入れ焼戻し処理することによって、最終目的の特性に適した高強度、高靱性、高寸法精度で加工性と溶接性に優れた鋼管を得ることができる。

【0017】

【発明の実施の形態】先ず本発明で使用する鋼材の化学成分に関する限定理由は以下のとおりである。Cは鋼の必要な強度を安価に得るために添加する元素であるが、0.01%未満では十分な強度が得られず、また、0.20%を超えると加工性ならびに溶接性が悪化すると共に、靱性が低下するため、0.01~0.20%としたが、特に好ましい範囲は、0.05%以上0.15%未満である。

【0018】Siは鋼の冷間加工性を阻害する元素であり、0.50%を超えると加工性が悪化するため、0.50%以下とした。

【0019】Mnは鋼の強度と靱性を向上させるのに有効な元素であるが、0.30%未満では十分な強度と靱性が得られず、また、2.00%を超えると溶接性が悪化するため、0.30~2.00%とした。

【0020】Pは粒界偏析に起因する靱性低下をもたらすため、0.020%以下とした。Sは鋼中のMnと化合してMnSによる介在物を形成し、加工性の悪化ならびに靱性を低下させるため、0.020%以下とした。

【0021】Alは加工性を向上させるのに有効な元素があるが、0.10%を超えるとその効果が小さくなるため、0.10%以下とした。

【0022】鋼中の上記化学成分を限定することによって、エアーバッグのアクキュムレータ用として十分な強

度、靱性と高加工性、溶接性を得ることができるが、さらにこれらを向上させたい場合、上記化学成分にさらにMo、V、Ni、Cr、Cu、Ti、Nb、Bを添加することが有効である。これら添加成分の含有量の限定理由は以下のとおりである。

【0023】Moは固溶強化により高強度化すると共に、焼入れ性を向上する効果があるが、0.50%を超えると溶接部が硬化し、靱性が低下するため、0.50%以下とした。

【0024】Vは析出物を生成し強度を向上させる効果があるが、0.10%を超えると溶接部の靱性が低下するため、0.10%以下とした。

【0025】Niは焼入れ性を改善すると共に靱性を向上させるのに有効な元素であるが、0.50%を超えてもその作用があるものの高価なため、0.50%以下とした。

【0026】Crは鋼の強度と耐食性を向上させるのに有効な元素であるが、1.00%を超えると加工性ならびに溶接部の靱性を低下させるため、1.00%以下とした。

【0027】Cuは鋼の耐食性を向上させるのに有効な元素であるが、0.50%を超えると熱間加工性を悪化させるため、0.50%以下とした。

【0028】Tiは組織を微細化することにより靱性の向上に有効であるが、0.10%を超えると逆に靱性を悪化させるため、0.10%以下とした。

【0029】NbはTiと同様に組織を微細化することにより靱性の向上に有効であるが、0.10%を超えると逆に靱性を悪化させるため、0.10%以下とした。

【0030】Bは焼入れ性を改善するのに有効な元素であるが、0.005%を超えると靱性を低下させるため、0.005%以下とした。

【0031】本発明においては、上記のように化学成分を調整した鋼材を素材として製管する。製管法としては、熱間圧延鋼帯を用いて電縫溶接する方法と、ビレットを用いて熱間製管する縫目無製管法があるが、いずれの方法でもよい。このようにして製管された鋼管は、エアバッグのアクチュレータ用として十分な強度、靱性と高寸法精度で高加工性と溶接性を確保することができる。

【0032】上記のように化学成分を調整した鋼材を素材として製管された鋼管は、所定の寸法精度が得られる条件下で冷間加工される。冷間加工は、所定の寸法精度

が得られる条件下で処理すればよく、特に加工度を規定する必要はない。

【0033】冷間加工後の熱処理は、目標の強度と加工性、靱性を付与するために行うが、加工性、靱性よりも高強度、高寸法精度が重視される場合には冷間加工のままとする。焼なまし処理は、若干強度が下がっても、高強度、高靱性が必要な場合に適用する。焼ならし処理は、強度よりも加工性、靱性を重視する場合に適用する。焼入れ焼戻し処理は、多少寸法精度が悪くなるが、高強度、高靱性を得ることができる。

【0034】上記の処理は、いずれも最終目標の特性に適した熱処理を実施することにより所望の特性を得ることができる。

【0035】

【実施例】表1に示す化学成分の本発明鋼および表2に示す化学成分の比較鋼のビレットを用い、マンネスマンマンドレル方式による穿孔、圧延を行ったのち、レデューサにより外径76.2mm、肉厚4.0mmに仕上げた縫目無鋼管を、冷間引抜き加工して外径65.0mm、肉厚3.2mmに仕上げ、冷間加工のままとするか、580℃の温度での焼なまし、900℃の温度での焼ならし、または、900℃の温度での焼入れ、580℃の温度での焼戻し処理を施したのち、各種の特性を評価した。その結果を表3および表4に示す。

【0036】特性の評価は、強度、靱性、加工性について実施した。強度については、JIS Z2201の金属材料引張試験片に規定の11号試験片を用い、JIS Z2241の金属材料引張試験方法に準じて引張試験を行った。靱性については、図1に示すとおり、縫目無鋼管1を鎖線で示すように半割となし、長さ10mmの半割試験片2を採取し、図2に示す落重試験装置の置台3上に半割試験片2を載置し、重さ5kgの重錘4を置台3上面から2000mmの位置から落下させ、割れの有無を調査した。なお、落重試験は、-40℃において10ヶ繰り返して試験し、割れ率で評価した。加工性については、へん平性で評価した。なお、へん平性は、図3に示すとおり、先端Rが10mmのVブロック(60°)の押工具5、5を用いて縫目無鋼管1が密着するまでへん平にし、最大へん平部の肩部6に割れの発生有無により評価し、割れの発生無は○、割れの発生有は×とした。

【0037】

【表1】

鋼	No.	化 学 成 分 (%)													
		C	Si	Mn	P	S	Al	Mo	V	Ni	Cr	Cu	Ti	Nb	B
本 発 明	1	0.10	0.30	1.30	0.010	0.010	0.020	-	-	-	-	-	-	-	-
	2	0.02	0.27	1.27	0.012	0.012	0.018	-	-	-	-	-	-	-	-
	3	0.19	0.29	1.28	0.011	0.010	0.023	-	-	-	-	-	-	-	-
	4	0.11	0.48	1.28	0.010	0.010	0.020	-	-	-	-	-	-	-	-
	5	0.11	0.25	0.34	0.009	0.011	0.024	-	-	-	-	-	-	-	-
	6	0.10	0.27	1.90	0.012	0.012	0.020	-	-	-	-	-	-	-	-
	7	0.09	0.30	1.31	0.019	0.010	0.025	-	-	-	-	-	-	-	-
	8	0.10	0.31	1.29	0.011	0.018	0.026	-	-	-	-	-	-	-	-
	9	0.11	0.31	1.30	0.012	0.011	0.025	-	-	-	-	-	-	-	-
	10	0.11	0.28	1.28	0.009	0.019	0.025	0.22	-	-	-	-	-	-	-
	11	0.10	0.30	1.27	0.008	0.011	0.020	-	0.07	-	-	-	-	-	-
	12	0.09	0.29	1.31	0.012	0.011	0.023	-	-	0.38	-	0.31	-	-	-
	13	0.10	0.33	1.29	0.011	0.011	0.025	-	-	-	0.51	-	-	-	-
	14	0.10	0.30	1.31	0.010	0.012	0.020	-	-	-	-	-	0.040	-	-
	15	0.09	0.31	1.28	0.012	0.008	0.024	-	-	-	-	-	-	0.04	-
	16	0.11	0.30	1.30	0.012	0.011	0.021	-	-	-	-	-	0.003	-	0.0012
	17	0.11	0.29	1.28	0.012	0.010	0.025	-	-	-	-	-	-	-	-
	18	0.10	0.29	1.29	0.010	0.009	0.024	-	-	-	-	-	-	-	-
	19	0.10	0.27	1.31	0.010	0.008	0.025	-	-	-	-	-	-	-	-

【0038】

\* \* 【表2】

鋼	No.	化 学 成 分 (%)													
		C	Si	Mn	P	S	Al	Mo	V	Ni	Cr	Cu	Ti	Nb	B
比 較 例	20	0.008*	0.28	1.29	0.011	0.010	0.027	-	-	-	-	-	-	-	-
	21	0.24*	0.29	1.31	0.009	0.008	0.029	-	-	-	-	-	-	-	-
	22	0.11	0.54*	1.30	0.011	0.012	0.025	-	-	-	-	-	-	-	-
	23	0.10	0.30	0.21*	0.012	0.011	0.024	-	-	-	-	-	-	-	-
	24	0.10	0.28	2.16*	0.010	0.009	0.023	-	-	-	-	-	-	-	-
	25	0.11	0.37	1.29	0.029*	0.010	0.025	-	-	-	-	-	-	-	-
	26	0.09	0.29	1.29	0.010	0.030*	0.024	-	-	-	-	-	-	-	-
	27	0.10	0.30	1.28	0.011	0.011	0.115*	-	-	-	-	-	-	-	-

\*印はこの発明の範囲外

【0039】

※30※ 【表3】

鋼	冷間加工後の	引張強さ	落重試験	密着
No.	熱処理種類	(N/mm <sup>2</sup> )	割れ率(%)	へん平
本 発 明 鋼	1 焼なまし	708	0	○
	2 焼なまし	598	0	○
	3 焼なまし	843	0	○
	4 焼なまし	716	0	○
	5 焼なまし	608	0	○
	6 焼なまし	834	0	○
	7 焼なまし	716	0	○
	8 焼なまし	706	0	○
	9 焼なまし	736	0	○
	10 焼なまし	765	0	○
	11 焼なまし	726	0	○
	12 焼なまし	745	0	○
	13 焼なまし	814	0	○
	14 焼なまし	716	0	○
	15 焼なまし	706	0	○
	16 焼なまし	726	0	○
	17 冷間加工まま	765	0	○
	18 焼ならし	657	0	○
	19 焼入れ焼戻し	726	0	○

【0040】

\* \* 【表4】

鋼	最終熱	引張強さ	落重試験	密着	備
No.	処理種類	(N/mm <sup>2</sup> )	割れ率(%)	へん平	考
比 較 鋼	20 焼なまし	481	0	○	強度不足
	21 焼なまし	873	40	×	靱性加工性不足
	22 焼なまし	736	10	×	靱性加工性不足
	23 焼なまし	559	0	○	強度不足
	24 焼なまし	853	30	×	靱性加工性不足
	25 焼なまし	696	30	×	靱性加工性不足
	26 焼なまし	686	20	×	靱性加工性不足
	27 焼なまし	716	30	×	靱性加工性不足

【0041】表1、表3に示すとおり、鋼No. 1～19の本発明鋼は、いずれの成分、プロセスにおいても、引張強さが590N/mm<sup>2</sup>以上の高強度で、しかも、落重試験での割れ率が0%、さらに、へん平後の肩部の割れがなく、良好な加工性を有していた。

【0042】これに対し、表2、表4に示すとおり、鋼No. 20～27の比較鋼は、鋼No. 20、23が引張強さが590N/mm<sup>2</sup>以下で強度不足、また、鋼No. 21、22、24～27は、落重試験での割れ率が10%以上で、しかも密着へん平後の肩部の割れが発生し、靱性ならびに加工性が不足している。なお、本実施例では、継目無鋼管の例を示したが、溶接鋼管を用いても同一の特性が得られることはいうまでもない。

【0043】

【発明の効果】本発明の請求項1～4の高強度、高靱性エアーバッグ用鋼管は、請求項1～4に記載のとおり化※50

※学成分を調整した鋼材を素材として製管することによって、エアーバッグのアクムレータ用等の用途に適した高寸法精度で加工性と溶接性に優れ、かつ高強度、高靱性を得ることができる。

【0044】本発明の請求項5～8の高強度、高靱性エアーバッグ用鋼管の製造方法は、本発明の請求項1～4に記載のとおり化学成分を調整した鋼を製管後、所定の寸法に冷間加工を施したまま、もしくは冷間加工後焼なまし、焼ならしまたは焼入れ焼戻し処理することによって、最終目標の特性に適した高強度、高靱性、高寸法精度で加工性と溶接性に優れたエアーバッグのアクムレータ用の鋼管を製造することができる。

【図面の簡単な説明】

【図1】実施例における落重試験片の説明図で、(a)図は半割方法の斜視図、(b)図は落重試験片の斜視図である。



【図2】実施例における落重試験方法説明のための概略説明図である。

【図3】実施例における密着へん平試験方法説明のための概略説明図である。

【符号の説明】

1 継目無銅管

2 半割試験片

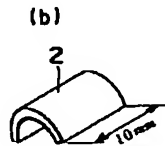
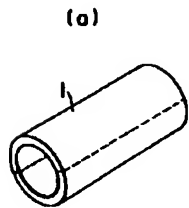
3 置台

4 重錘

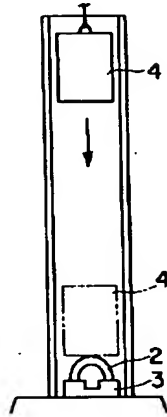
5 押工具

6 肩部

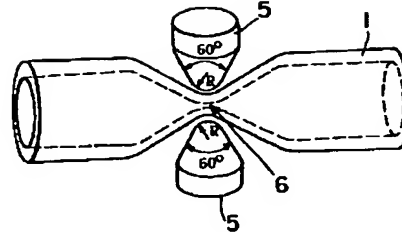
【図1】



【図2】



【図3】



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1. This document has been translated by computer. So the translation may not reflect the original precisely.
2. \*\*\*\* shows the word which can not be translated.
3. In the drawings, any words are not translated.

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CLAIMS

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[Claim(s)]

[Claim 1] The steel pipe for high intensity high toughness air bags with which less than [ aluminum:0.10% ] is contained less than 0.15% C:0.05% or more less than [ Si:0.50% ], Mn:0.30%-2.00%, P:0.020% or less, and S:0.020% or less, and the remainder consists of Fe and an unescapable impurity.

[Claim 2] Less than 0.15% C:0.05% or more, less than [ Si:0.50% ], Mn:0.30%-2.00%, Less than [ aluminum:0.10% ] is included P:0.020% or less and S:0.020% or less. Mo: Less than [ 0.50% ], V:0.10% or less, less than [ nickel:0.50% ], Cr: The steel pipe for high intensity high toughness air bags with which one or more of less than [ 1.00% ], less than [ Cu:0.50% ], less than [ Ti:0.10% ], less than [ Nb:0.10% ], and B:0.005% or less of sorts are contained, and the remainder consists of Fe and an unescapable impurity.

[Claim 3] The steel pipe for high intensity high toughness air bags with which less than [ aluminum:0.10% ] is contained C:0.01% to 0.20% less than [ Si:0.50% ], Mn:0.30%-2.00%, P:0.020% or less, and S:0.020% or less, and the remainder consists of Fe and an unescapable impurity.

[Claim 4] C:0.01% - 0.20%, less than [ Si:0.50% ], Mn:0.30%-2.00%, Less than [ aluminum:0.10% ] is included P:0.020% or less and S:0.020% or less. Mo: Less than [ 0.50% ], V:0.10% or less, less than [ nickel:0.50% ], Cr: The steel pipe for high intensity high toughness air bags with which one or more of less than [ 1.00% ], less than [ Cu:0.50% ], less than [ Ti:0.10% ], less than [ Nb:0.10% ], and B:0.005% or less of sorts are contained, and the remainder consists of Fe and an unescapable impurity.

[Claim 5] The manufacture approach of the steel pipe for high intensity high toughness air bags which carries out as or cold-working afterbaking raw, and is characterized by the thing for which cold working was performed to the predetermined dimension, and which is normalized or hardening tempering processed after manufacturing the steel with which less than [ aluminum:0.10% ] is contained less than 0.15% C:0.05% or more less than [ Si:0.50% ], Mn:0.30%-2.00%, P:0.020% or less, and S:0.020% or less and the remainder consists of Fe and an unescapable impurity

[Claim 6] Less than 0.15% C:0.05% or more, less than [ Si:0.50% ], Mn:0.30%-2.00%, Less than [ aluminum:0.10% ] is included P:0.020% or less and S:0.020% or less. Mo: Less than [ 0.50% ], V:0.10% or less, less than [ nickel:0.50% ], Cr: Less than [ 1.00% ], less than [ Cu:0.50% ], less than [ Ti:0.10% ], Cold working has been performed to the predetermined dimension after manufacturing the steel with which one or more of less than [ Nb:0.10% ] and B:0.005% or less of sorts are contained, and the remainder consists of Fe and an unescapable impurity. Or the manufacture approach of the steel pipe for high intensity high toughness air bags which carries out cold-working afterbaking raw and is characterized by normalizing or hardening tempering processing.

[Claim 7] The manufacture approach of the steel pipe for high intensity high toughness air bags which carries out as or cold-working afterbaking raw, and is characterized by the thing for which cold working was performed to the predetermined dimension, and which is normalized or hardening tempering processed after manufacturing the steel with which less than [ aluminum:0.10% ] is contained and the remainder consists of Fe and an unescapable impurity C:0.01% to 0.20% less than [ Si:0.50% ],

Mn:0.30%-2.00%, P:0.020% or less, and S:0.020% or less.

[Claim 8] C:0.01% - 0.20%, less than [ Si:0.50% ], Mn:0.30%-2.00%, Less than [ aluminum:0.10% ] is included P:0.020% or less and S:0.020% or less. Mo: Less than [ 0.50% ], V:0.10% or less, less than [ nickel:0.50% ], Cr: Less than [ 1.00% ], less than [ Cu:0.50% ], less than [ Ti:0.10% ], Cold working has been performed to the predetermined dimension after manufacturing the steel with which one or more of less than [ Nb:0.10% ] and B:0.005% or less of sorts are contained, and the remainder consists of Fe and an unescapable impurity. Or the manufacture approach of the steel pipe for high intensity high toughness air bags which carries out cold-working afterbaking raw and is characterized by normalizing or hardening tempering processing.

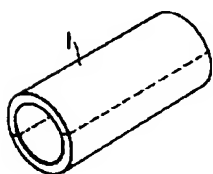
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[Translation done.]

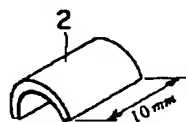
Drawing selection drawing 1

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(a)



(b)



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[Translation done.]

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## DETAILED DESCRIPTION

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### [Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the steel pipe for high intensity high toughness air bags suitable for the air bags as which it excels in workability and weldability with high dimensional accuracy, and the high intensity of two or more [ 590Ns //mm ] and high toughness are required, and its manufacture approach.

[0002]

[Description of the Prior Art] Although installation of the equipment which pursued safety is positively advanced in the automobile industry in recent years, before crew collides with a handle, an instrument panel, etc. also in it at the time of a collision, development loading of the air bag system which is made to develop an air bag by gas etc. between them and crew, absorbs crew's kinetic energy, and aims at injury relief has come to be carried out. Although the method which uses an explosive chemical conventionally had been adopted as an air bag system, it is expensive and the system which uses the accumulator made from an argon gas-charging steel pipe from an environmental problem and a recycle problem in recent years was developed. After the steel pipe used for accumulators, such as argon gas, always maintains at 300 kgf/cm<sup>2</sup> the inert gas which blows off in an air bag at the time of a collision, since the gas at the time of little powder ignition is added at the time of a collision, gas is gushed at a stretch and stress is added with the very big strain rate for a short time, unlike the mere structure like the conventional pressure cylinder or a line pipe, high dimensional accuracy, workability, and weldability are required with high intensity and high toughness.

[0003] In the case of the accumulator made from a steel pipe used for this application, toughness cannot fall by high intensity-ization, and it cannot be satisfied with the combination of conventional cold drawing processing and stress relieving annealing of the above-mentioned demand. Moreover, even if high intensity, high toughness, and high workability were acquired only by carrying out hardening annealing of the steel pipe, it had troubles -- predetermined high dimensional accuracy is not acquired.

[0004] As other approaches, moreover, C:0.15 - 0.30%, Si:0.05-0.50%, Mn:0.30-1.00%, P:0.040% or less, and S:0.010% or less are included. After the remainder is made from the welded tube which consists of Fe and an unescapable impurity and considers as a bainite texture by hardening annealing, Cold drawing, the approach of carrying out stress relieving annealing (JP,4-191323,A), C:0.15 - 0.40%, Si:0.1-0.7%, Mn:0.5-2.5%, Cr:0.2-2.5% and Sol.aluminum:0.01-0.05% are contained. The steel with which the remainder consists of Fe and an unescapable impurity or C:0.15 - 0.40%, Si:0.1-0.7%, Mn:0.5-2.5%, Cr:0.2-2.5%, and Sol.aluminum:0.01-0.05%, Mo: 0.05-1.0%, V:0.02 - 0.1%, nickel:0.2-2.5%, Contain one or more of Ti:0.02-0.10%, Nb:0.02-0.10%, and B:0.0005 - 0.005% of sorts, and are made from the steel with which the remainder consists of Fe and an unescapable impurity. It considers as hot rolled sheet steel with hot rolling, and after softening, after cold-working the steel pipe fabricated, welded and manufactured by the shape of tubing so that it may become a predetermined part shape, the approach (JP,5-302119,A) of carrying out after [ heating during for 0.5 - 30 minutes ] air cooling at 850-1050 degrees C etc. is proposed.

[0005]

[Problem(s) to be Solved by the Invention] Although the approach of the disclosure to above-mentioned JP,4-191323,A aims at improvement in the cutting ability by bainite-texture-izing, in order to obtain a bainite texture with hardening, it needs to make the amount of C surely increase, and it is necessary to make it into C:0.15 - 0.30%, and a high value. However, when the amount of C is made high in this way and it considers as a bainite texture, generally ductility and toughness are scarce, it is unsuitable for an application to which tube-end spinning is carried out for the accumulators of an air bag, and, moreover, there is a problem in weldability etc.

[0006] Like the approach of the disclosure to above-mentioned JP,4-191323,A, C:0.15 - 0.40%, and since it is high, generally the approach of the disclosure to JP,5-302119,A is deficient in ductility and toughness, and is unsuitable for an application like the accumulator for air bags by which tube-end spinning is carried out, and, moreover, there is a problem in weldability etc.

[0007] The object of this invention is to offer the high intensity high toughness steel pipe excellent in the workability suitable for the components for air bags with which the fault of the above-mentioned conventional technique is canceled, and it excels in workability and weldability with high dimensional accuracy, and high intensity and high toughness are demanded, and its manufacture approach.

[0008]

[Means for Solving the Problem] this invention persons repeated test research wholeheartedly that the above-mentioned object should be attained. Consequently, the predetermined chemical entity suitable for the accumulators of an air bag system was found out. Moreover, in order to perform cold working after manufacturing the steel of said predetermined chemical entity in order to acquire predetermined dimensional accuracy, and to acquire an after that predetermined property, when not heat-treating, by annealing and performing normalizing or hardening tempering processing, it studied that excelled in workability and weldability with high dimensional accuracy, and high intensity and a high toughness steel pipe were obtained, and this invention was reached.

[0009] The steel pipe for high intensity high toughness air bags of claim 1 of this invention contains less than [ aluminum:0.10% ] less than 0.15% C:0.05% or more less than [ Si:0.50% ], Mn:0.30%-2.00%, P:0.020% or less, and S:0.020% or less, and the remainder consists of Fe and an unescapable impurity. Thus, high workability and weldability are securable with reinforcement sufficient as an object for the accumulators of an air bag, and toughness and high dimensional accuracy by limiting the chemical entity in steel to the above-mentioned component presentation.

[0010] Moreover, the steel pipe for high intensity high toughness air bags of claim 2 of this invention Less than 0.15% C:0.05% or more, less than [ Si:0.50% ], Mn:0.30%-2.00%, Less than [ aluminum:0.10% ] is included P:0.020% or less and S:0.020% or less. Mo: Less than [ 0.50% ] and V:0.10% or less, contain one or more of less than [ nickel:0.50% ], less than [ Cr:1.00% ], less than [ Cu:0.50% ], less than [ Ti:0.10% ], less than [ Nb:0.10% ], and B:0.005% or less of sorts, and the remainder consists of Fe and an unescapable impurity. Thus, high workability and weldability are securable with reinforcement sufficient as an object for the accumulators of an air bag, and toughness and high dimensional accuracy by limiting the chemical entity in steel to the above-mentioned component presentation.

[0011] Furthermore, the steel pipe for high intensity high toughness air bags of claim 3 of this invention contains less than [ aluminum:0.10% ] C:0.01% to 0.20% less than [ Si:0.50% ], Mn:0.30%-2.00%, P:0.020% or less, and S:0.020% or less, and the remainder consists of Fe and an unescapable impurity. Thus, high workability and weldability are securable with reinforcement sufficient as an object for the accumulators of an air bag, and toughness and high dimensional accuracy by limiting the chemical entity in steel to the above-mentioned component presentation.

[0012] Further again the steel pipe for high intensity high toughness air bags of claim 4 of this invention C:0.01% - 0.20%, less than [ Si:0.50% ], Mn:0.30%-2.00%, Less than [ aluminum:0.10% ] is included P:0.020% or less and S:0.020% or less. Mo: Less than [ 0.50% ] and V:0.10% or less, contain one or more of less than [ nickel:0.50% ], less than [ Cr:1.00% ], less than [ Cu:0.50% ], less than [ Ti:0.10% ], less than [ Nb:0.10% ], and B:0.005% or less of sorts, and the remainder consists of Fe and an

unescapable impurity. Thus, high workability and weldability are securable with reinforcement sufficient as an object for the accumulators of an air bag, and toughness and high dimensional accuracy by limiting the chemical entity in steel to the above-mentioned component presentation.

[0013] Moreover, the manufacture approach of the steel pipe for high intensity high toughness air bags of claim 5 of this invention Less than 0.15% C:0.05% or more, less than [ Si:0.50% ], Mn:0.30%-2.00%, P:0.020% or less and S:0.020% or less, less than [ aluminum:0.10% ] is contained, and after manufacturing the steel with which the remainder consists of Fe and an unescapable impurity, as or cold-working afterbaking raw are carried out, and it \*\*\*\*s to the thing for which cold working was performed to the predetermined dimension and which is normalized or hardening tempering processed. Thus, high workability and weldability are securable with reinforcement sufficient as an object for the accumulators of an air bag, and toughness and high dimensional accuracy by limiting the chemical entity in steel to the above-mentioned component presentation. Moreover, after manufacturing the above-mentioned steel, as or cold-working afterbaking raw can be carried out, and the steel pipe which was excellent in workability and weldability with the high intensity suitable for the property of the last object, high toughness, and high dimensional accuracy can be obtained by [ for which cold working was performed to the predetermined dimension ] normalizing or hardening tempering processing.

[0014] Furthermore, the manufacture approach of the steel pipe for high intensity high toughness air bags of claim 6 of this invention Less than 0.15% C:0.05% or more, less than [ Si:0.50% ], Mn:0.30%-2.00%, Less than [ aluminum:0.10% ] is included P:0.020% or less and S:0.020% or less. Mo: Less than [ 0.50% ], V:0.10% or less, less than [ nickel:0.50% ], Cr: Less than [ 1.00% ], less than [ Cu:0.50% ], less than [ Ti:0.10% ], Nb: Contain one or more of less than [ 0.10% ] and B:0.005% or less of sorts, after manufacturing the steel with which the remainder consists of Fe and an unescapable impurity, carry out as or cold-working afterbaking raw, and \*\*\*\* to the thing for which cold working was performed to the predetermined dimension and which is normalized or hardening tempering processed. Thus, high workability is securable with reinforcement sufficient as an object for the accumulators of an air bag, and toughness and high dimensional accuracy by limiting the chemical entity in steel to the above-mentioned component presentation. Moreover, after manufacturing the above-mentioned steel, as or cold-working afterbaking raw can be carried out, and the steel pipe which was excellent in workability and weldability with the high intensity suitable for the property of the last object, high toughness, and high dimensional accuracy can be obtained by [ for which cold working was performed to the predetermined dimension ] normalizing or hardening tempering processing.

[0015] Further again the manufacture approach of the steel pipe for high intensity high toughness air bags of claim 7 of this invention C:0.01% - 0.20%, less than [ Si:0.50% ], Mn:0.30%-2.00%, P:0.020% or less and S:0.020% or less, less than [ aluminum:0.10% ] is contained, and after manufacturing the steel with which the remainder consists of Fe and an unescapable impurity, as or cold-working afterbaking raw are carried out, and it \*\*\*\*s to the thing for which cold working was performed to the predetermined dimension and which is normalized or hardening tempering processed. Thus, high workability and weldability are securable with reinforcement sufficient as an object for the accumulators of an air bag, and toughness and high dimensional accuracy by limiting the chemical entity in steel to the above-mentioned component presentation. Moreover, after manufacturing the above-mentioned steel, as or cold-working afterbaking raw can be carried out, and the steel pipe which was excellent in workability and weldability with the high intensity suitable for the property of the last object, high toughness, and high dimensional accuracy can be obtained by [ for which cold working was performed to the predetermined dimension ] normalizing or hardening tempering processing.

[0016] Moreover, the manufacture approach of the steel pipe for high intensity high toughness air bags of claim 8 of this invention C:0.01% - 0.20%, less than [ Si:0.50% ], Mn:0.30%-2.00%, Less than [ aluminum:0.10% ] is included P:0.020% or less and S:0.020% or less. Mo: Less than [ 0.50% ], V:0.10% or less, less than [ nickel:0.50% ], Cr: Less than [ 1.00% ], less than [ Cu:0.50% ], less than [ Ti:0.10% ], Nb: Contain one or more of less than [ 0.10% ] and B:0.005% or less of sorts, after manufacturing the steel with which the remainder consists of Fe and an unescapable impurity, carry out as or cold-working afterbaking raw, and \*\*\*\* to the thing for which cold working was performed to the

predetermined dimension and which is normalized or hardening tempering processed. Thus, high workability and weldability are securable with reinforcement sufficient as an object for the accumulators of an air bag, and toughness and high dimensional accuracy by limiting the chemical entity in steel to the above-mentioned component presentation. Moreover, after manufacturing the above-mentioned steel, as or cold-working afterbaking raw can be carried out, and the steel pipe which was excellent in workability and weldability with the high intensity suitable for the property of the last object, high toughness, and high dimensional accuracy can be obtained by [ for which cold working was performed to the predetermined dimension ] normalizing or hardening tempering processing.

[0017]

[Embodiment of the Invention] The reason for definition about the chemical entity of the steel first used by this invention is as follows. Although it considered as 0.01 - 0.20% since toughness fell while workability and weldability got worse when reinforcement sufficient at less than 0.01% was not obtained and it exceeded 0.20% although it was the element added in order that C may obtain the required reinforcement of steel cheaply, especially the desirable range is less than 0.15% 0.05% or more.

[0018] Si was an element which checks the cold-working nature of steel, and since workability would get worse if it exceeds 0.50%, it could be 0.50% or less.

[0019] Although Mn was an element effective in raising the reinforcement and the toughness of steel, since weldability would get worse if reinforcement and toughness sufficient at less than 0.30% are not acquired and it exceeds 2.00%, it could be 0.30 - 2.00%.

[0020] P could be 0.020% or less in order to bring about the toughness lowering resulting from grain boundary segregation. In order that S might combine with Mn in steel, might form the inclusion by MnS and might reduce aggravation and the toughness of workability, it could be 0.020% or less.

[0021] Although aluminum had an element effective in raising workability, since the effectiveness would become small if it exceeds 0.10%, it could be 0.10% or less.

[0022] Although reinforcement sufficient as an object for the accumulators of an air bag, toughness and high workability, and weldability can be obtained by limiting the above-mentioned chemical entity in steel, when these want to improve further, it is effective in the above-mentioned chemical entity to add Mo, V, nickel, Cr, Cu, Ti, Nb, and B further. The reason for definition of the content of these addition component is as follows.

[0023] Mo was effective in improving hardenability while high-intensity-izing it by solid solution strengthening, but since a weld zone would harden and toughness would fall if it exceeds 0.50%, it could be 0.50% or less.

[0024] Although V was effective in generating a sludge and raising reinforcement, since the toughness of a weld zone would fall if it exceeds 0.10%, it could be 0.10% or less.

[0025] While having improved hardenability, it was an element effective in raising toughness, but although nickel had the operation even if it exceeded 0.50%, since it was expensive, it was made into 0.50% or less.

[0026] Although Cr was an element effective in raising the reinforcement of steel, and corrosion resistance, if it exceeds 1.00%, in order to reduce workability and the toughness of a weld zone, it could be 1.00% or less.

[0027] Although Cu was an element effective in raising the corrosion resistance of steel, if it exceeds 0.50%, in order to worsen hot-working nature, it could be 0.50% or less.

[0028] Although Ti was effective in improvement in toughness by making an organization detailed, if it exceeds 0.10%, in order to worsen toughness conversely, it could be 0.10% or less.

[0029] Although Nb was effective in improvement in toughness by making an organization detailed like Ti, if it exceeds 0.10%, in order to worsen toughness conversely, it could be 0.10% or less.

[0030] Although B was an element effective in improving hardenability, if it exceeds 0.005%, in order to reduce toughness, it could be 0.005% or less.

[0031] In this invention, the steel which adjusted the chemical entity as mentioned above is manufactured as a raw material. Which approach may be used although there are the approach of



carrying out electric resistance welding, using a hot rolled steel plates sheet and strip in coil as a manufacturing-tubes method and the joint-less manufacturing-tubes method manufactured between heat using a billet. Thus, the manufactured steel pipe can secure high workability and weldability with reinforcement sufficient as an object for the accumulators of an air bag, and toughness and high dimensional accuracy.

[0032] It cold-works the steel pipe manufactured considering the steel which adjusted the chemical entity as mentioned above as a raw material under the conditions from which predetermined dimensional accuracy is acquired. It is not necessary to specify especially workability that what is necessary is just to process cold working under the conditions from which predetermined dimensional accuracy is acquired.

[0033] Heat treatment after cold working is performed in order to give target reinforcement, workability, and toughness, but when greater importance is attached than to workability and toughness to high intensity and high dimensional accuracy, it is considered as as [ cold working ]. Even if reinforcement falls a little, annealing processing is applied when high intensity and high toughness are required.

Normalizing processing is applied when attaching greater importance than to reinforcement to workability and toughness. Some hardening tempering processings can acquire high intensity and high toughness, although dimensional accuracy worsens.

[0034] Each above-mentioned processing can acquire a desired property by carrying out heat treatment suitable for the property of a policy objective.

[0035]

[Example] The billet of the comparison steel of the chemical entity shown in this invention steel and the table 2 of a chemical entity showing in a table 1 is used. After performing punching by the Mannesmann-mandrel mill method, and rolling, The seamless steel tubes to which the outer diameter of 76.2mm and the thickness of 4.0mm were made by the reducer After having carried out cold drawing processing, and considering as as [ finishing and cold working ] at the outer diameter of 65.0mm, and the thickness of 3.2mm or performing annealing at the temperature of 580 degrees C, normalizing at the temperature of 900 degrees C or hardening-at the temperature of 900 degrees C, and tempering processing at the temperature of 580 degrees C, various kinds of properties were evaluated. The result is shown in a table 3 and a table 4.

[0036] Assessment of a property was carried out about reinforcement, toughness, and workability.

About reinforcement, it is JIS. A regular No. 11 test piece is used for the metallic material test piece for tensile test of Z2201, and it is JIS. The tension test was performed according to the metallic material tension test approach of Z2241. About toughness, the half-segmented test piece 2 was laid on the table 3 of the drop weight test equipment which extracts half-segmented, nothing, and the half-segmented test piece 2 with a die length of 10mm as the chain line shows, and shows seamless steel tubes 1 to drawing 2, the weight 4 with a weight of 5kg was dropped from the location of 2000mm from table 3 top face, and the existence of a crack was investigated as shown in drawing 1. In addition, ten drop weight tests were repeatedly examined in -40 degrees C, and the rate of a crack estimated them. Flat nature estimated workability. In addition, it was made flat until seamless steel tubes 1 stuck flat nature using \*\*\*\*\* 5 and 5 of the V block (60 degrees) whose head R is 10mm as it was shown in drawing 3 R> 3, and it evaluated by generating existence of a crack to the shoulder 6 of the maximum flat section, and nothing [ generating ] of a crack made \*\*\*\*\* of O and a crack x.

[0037]

[A table 1]

	鋼	化 学 成 分 (%)														
		No.	C	Si	Mn	P	S	Al	Mo	V	Ni	Cr	Cu	Ti	Nb	B
本 発 明	1	0.10	0.30	1.30	0.010	0.010	0.020	-	-	-	-	-	-	-	-	-
	2	0.02	0.27	1.27	0.012	0.012	0.018	-	-	-	-	-	-	-	-	-
	3	0.19	0.29	1.28	0.011	0.010	0.023	-	-	-	-	-	-	-	-	-
	4	0.11	0.48	1.28	0.010	0.010	0.020	-	-	-	-	-	-	-	-	-
	5	0.11	0.25	0.34	0.009	0.011	0.024	-	-	-	-	-	-	-	-	-
	6	0.10	0.27	1.90	0.012	0.012	0.020	-	-	-	-	-	-	-	-	-
	7	0.09	0.30	1.31	0.019	0.010	0.025	-	-	-	-	-	-	-	-	-
	8	0.10	0.31	1.29	0.011	0.018	0.026	-	-	-	-	-	-	-	-	-
	9	0.11	0.31	1.30	0.012	0.011	0.085	-	-	-	-	-	-	-	-	-
	10	0.11	0.28	1.28	0.009	0.012	0.025	0.22	-	-	-	-	-	-	-	-
鋼	11	0.10	0.30	1.27	0.008	0.011	0.020	-	0.07	-	-	-	-	-	-	-
	12	0.09	0.29	1.31	0.012	0.011	0.023	-	-	0.38	-	0.31	-	-	-	-
	13	0.10	0.33	1.29	0.011	0.011	0.025	-	-	-	0.51	-	-	-	-	-
	14	0.10	0.30	1.31	0.010	0.012	0.020	-	-	-	-	-	0.040	-	-	-
	15	0.09	0.31	1.28	0.012	0.008	0.024	-	-	-	-	-	-	0.04	-	-
	16	0.11	0.30	1.30	0.012	0.011	0.021	-	-	-	-	-	-	0.003	-	0.0012
	17	0.11	0.29	1.28	0.012	0.010	0.025	-	-	-	-	-	-	-	-	-
	18	0.10	0.29	1.29	0.010	0.009	0.024	-	-	-	-	-	-	-	-	-
	19	0.10	0.27	1.31	0.010	0.008	0.025	-	-	-	-	-	-	-	-	-

[0038]

[A table 2]

	鋼	化 学 成 分 (%)													
		No.	C	Si	Mn	P	S	Al	Mo	V	Ni	Cr	Cu	Ti	Nb
比  較   鋼	20	0.008*	0.28	1.29	0.011	0.010	0.027	-	-	-	-	-	-	-	-
	21	0.24*	0.29	1.31	0.009	0.008	0.029	-	-	-	-	-	-	-	-
	22	0.11	0.54*	1.30	0.011	0.012	0.025	-	-	-	-	-	-	-	-
	23	0.10	0.30	0.21*	0.012	0.011	0.024	-	-	-	-	-	-	-	-
	24	0.10	0.28	2.15*	0.010	0.009	0.023	-	-	-	-	-	-	-	-
	25	0.11	0.27	1.29	0.029*	0.010	0.025	-	-	-	-	-	-	-	-
	26	0.09	0.29	1.29	0.010	0.030*	0.024	-	-	-	-	-	-	-	-
	27	0.10	0.30	1.28	0.011	0.011	0.115*	-	-	-	-	-	-	-	-

\*印はこの発明の範囲外

[0039]

[A table 3]

	鋼	冷間加工後の	引張強さ	落重試験	密着
	No.	熱処理種類	(N/mm <sup>2</sup> )	割れ率(%)	へん平
本 発 明 鋼	1	焼なまし	706	0	○
	2	焼なまし	598	0	○
	3	焼なまし	843	0	○
	4	焼なまし	716	0	○
	5	焼なまし	608	0	○
	6	焼なまし	834	0	○
	7	焼なまし	716	0	○
	8	焼なまし	706	0	○
	9	焼なまし	736	0	○
	10	焼なまし	765	0	○
	11	焼なまし	726	0	○
	12	焼なまし	745	0	○
	13	焼なまし	814	0	○
	14	焼なまし	716	0	○
	15	焼なまし	706	0	○
	16	焼なまし	726	0	○
	17	冷間加工まま	765	0	○
	18	焼ならし	657	0	○
	19	焼入れ焼戻し	726	0	○

[0040]

[A table 4]

	鋼	最終熱	引張強さ	落重試験	密着	備
	No.	処理種類	(N/mm <sup>2</sup> )	割れ率(%)	へん平	考
比 較 鋼	20	焼なまし	481	0	○	強度不足
	21	焼なまし	873	40	×	靱性加工性不足
	22	焼なまし	736	10	×	靱性加工性不足
	23	焼なまし	559	0	○	強度不足
	24	焼なまし	853	30	×	靱性加工性不足
	25	焼なまし	696	30	×	靱性加工性不足
	26	焼なまし	686	20	×	靱性加工性不足
	27	焼なまし	716	30	×	靱性加工性不足

[0041] Also in which component and the process, tensile strength was the high intensity of two or more [ 590Ns //mm ], moreover, the crack of the shoulder after flat does not have further a 0% rate of a crack in a drop weight test, and, as for this invention steel of steel No.1-19, it had good workability as shown in a table 1 and a table 3.

[0042] on the other hand, as being shown in a table 2 and a table 4 -- the comparison steel of steel No.20-27 -- steel No. -- for 20 and 23, tensile strength is [ the rate of a crack in a drop weight test ] 10% or more or less [ 590Ns //mm ] in two, and moreover the crack of the shoulder after adhesion flat occurs, and the lack of on the strength and steel No.21, and 22, 24-27 are insufficient of toughness and workability. In addition, at this example, although the example of seamless steel tubes was shown, even if it uses a welded steel pipe, it cannot be overemphasized that the same property is acquired.

[0043]

[Effect of the Invention] By manufacturing the steel which adjusted the chemical entity the passage

according to claim 1 to 4 as a raw material, the high intensity of claims 1-4 of this invention and the steel pipe for high toughness air bags are excellent in workability and weldability with the high dimensional accuracy suitable for the applications for the accumulators of an air bag etc., and can acquire high intensity and high toughness.

[0044] The high intensity of claims 5-8 of this invention, and the manufacture approach of the steel pipe for high toughness air bags Carry out as or cold-working afterbaking raw, and by [ for which cold working was performed to the predetermined dimension after manufacturing the steel which adjusted the chemical entity as / according to claim 1 to 4 / this invention ] normalizing or hardening tempering processing The steel pipe for the accumulators of the air bag which was excellent in workability and weldability with the high intensity suitable for the property of a policy objective, high toughness, and high dimensional accuracy can be manufactured.

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[Translation done.]